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3D models of historical objects in teaching at the 1st level of primary school

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Abstract

The aim of the study was to find out what effect has on teaching process utilization of gamification elements, concrete 3D models of historical objects from the Czech Republic in the subject Man and his world if introduction of gamification effects pedagogical interaction and communication between teacher and pupils. Three lessons were analyzed on the base of videos. In each followed lesson the index of interaction was higher than 1, so pupils were more active than teacher. Discussions with teachers and their reflection of lesson were realized for completing. Introduction of 3D models in lessons and even elements of gamification could influence pedagogical interaction and communication between teacher and pupils. On the other hand we must be aware of that the constructive approach to teaching and thus an increase of activity does not depend on technology but in the first place on the personality and competences of teacher.

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Keywords: Interaction and communication; gamification 3D models

1. Introduction

Nowadays when children are since early childhood in close connection with information and communication technologies and a great part of their free time the spend by playing computer games, it is outright that even education of this generation would be partially provided in virtual environment. So it is environment, which is close to them. One of the ways how to make information closer by help of modern technologies, is using of 3D

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technologies. In this case it is 3D virtual sight-seeing tour of medieval castle with interactive elements, it means that it is possible „to go through“ and each significant element of construction (historical, architectural, etc.) could be activated and so obtained more detailed information about it.

Approaching of cultural heritage of the Czech Republic by means of interactive virtual models of historical constructions seems to be suitable connection of modern technologies and classical teaching from the educational area Man and his world on the first level of basic schools.

2. Theoretical background

2.1. Gamification

Gamification means generally transforming of game elements to another environment (surroudings).Basic strategy of gamification is to reach award for „players“ (pupils, students or participants of the course), if they carry out required tasks. The term gamification became more frequent after 2010 (Detergding, 2011).

According to Garthner curve of Hypo cycle from July 2012, gamification is approximately 5 up to 10 years before its peak when it will be widely and on mass scale exploited (Fig.1).

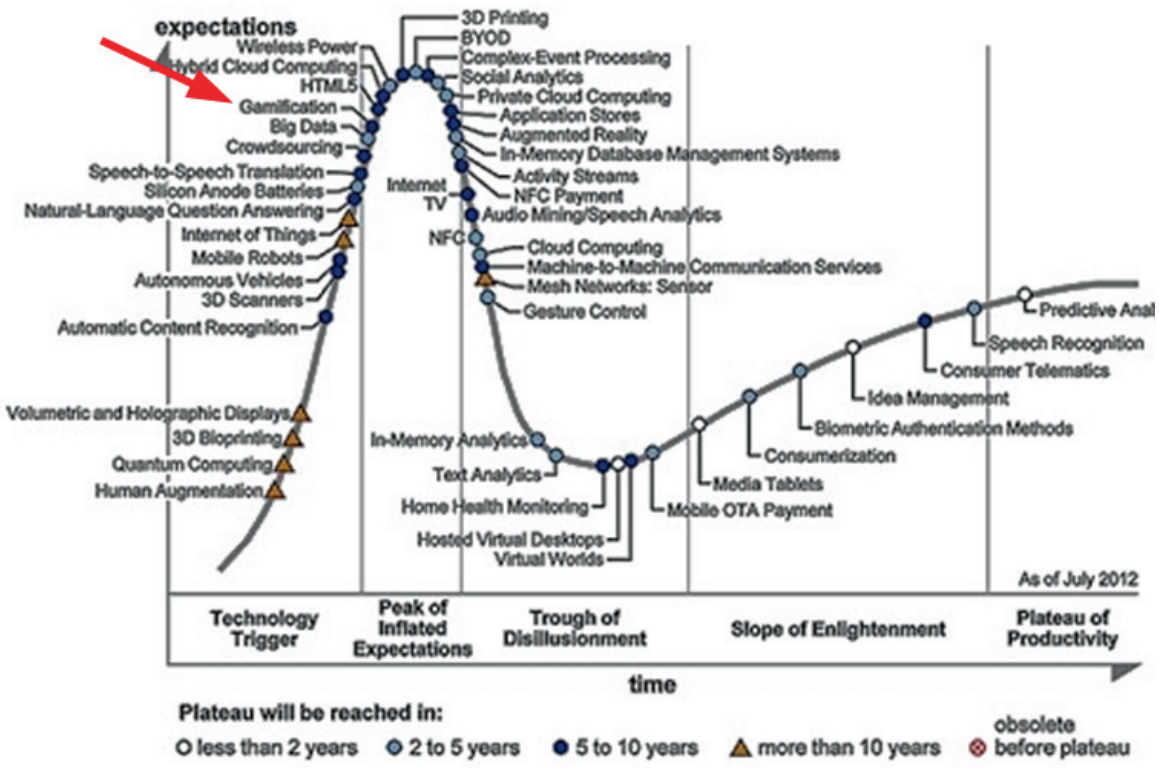

Fig.1. Garthner curve of Hypo cycle

2.2. 3D models

3D modelling understood as creation of three dimensional objects in virtual reality, is nowadays projected in all branches of human activity. People generally meet most often with 3D models in entertainment industry in the form of computer games or films either in the form of scene accessories in feature films or in full length films created only by this technology (animated films). Its role, non substitute at present, 3D models play in industry, e.g. at forming prototypes, alike in medicine at prosthesis production for after injury treatment or at treatment of the inborn defects.

3D model originated in specialized software. Selection of suitable software depends on the purpose of 3D model creation. If the 3D model is determined for industry or medicine, where exact values are necessary, software with parametric system.

m is selected, where exact calculations are in progress (e.g. Autodesk Inventor). If it is case of 3D model, where exactness is not necessary, mostly determined for entertainment industry, some software from so-called free models is chosen (e.g. Autodesk 3DS MAX), where priority is given to creativity before exactness. The formed 3D model is possible to leave in virtual surroundings and further adjust it here or print it on so-called 3D printer and this way virtual 3D model „materialize" into real world.

3. Theoretical background

Our goal was to exploit the gamification elements in teaching Man and his world at the 1st level of primary school. We came out from the subject matter of the 3rd class and aimed the model at thematic circle - Place, where we live. With regard to a fact that we cooperated with the schools in Hradec Králové, a burned out medieval castle in Hradec Králové was selected as a virtual model of historical object. Virtual 3D reconstruction of medieval castle in Hradec Králové was carried out on the base of analogy with preserved medieval castles and also due to reality that the castle was destroyed during Hussite wars (civil war in the 15th century). The castle was not reconstructed later and no document was preserved. As a concrete base for modelling of castle was used, after minor adaptation, sketches and graphic projects, which were originally intended (determined) for paper model, which is placed in the permanent exposition of East Bohemia museum in Hradec Králové.

Adaptation of the sets with ground plans, sectional views was done in GIMP 2.8 software and in the same way processing and textures preparation. Formation of 3D model of was preserved castle was carried out in 3Ds MAX 2011 together with texturing. Interactive presentation then arose by paneling of finished 3D model in software Unity 3D.

Creation of castle objects was realized in three different ways – using objects *„Standard Primitive"* (basic geometric primitives) and their contingent deformation, tools from the set *„AEC Extended"* (objects determined for architecture, underground services, structural and construction projection), further the bare walls were mounted with doors and windows in function from 3Ds MAX 2011 gallery. Modulation of more complicated architectural forms (shapes), e.g. arcades or broken arch were formed again mostly by deformation of standard „Standard Primitive" in combination of so-called Boolean operations (*„Boolean" or „ProBoolean")* - operation for addition or deduction of mass volume of the objects) and their sub-operations. Further from frequently used method for model formation was sketching of the contour of required shape by help of the tool *„Line"* and its space forming by the command „*Extrude*".

Completing work in 3Ds MAX 2011 was texturing and export of 3D model. Assignation of already prepared textures was realized in *„Material Editor",* where further parameters concerning appearance, characters of behavior on the model were assassinated to the textures. After finishing of texturation 3D model of the castle was exported to FBX format.

Interactive „transit" presentation of 3D model of castle was realized in Unity3D software. In this place partly visual completing of the whole scene and partly programmed interactivity took place. Final visual touches of the scene included lighting up of the scene and creating surroundings of the castle (sky, green, accessible road, vicinity of the castle).

Interactivity is formed by cameras and the elements, which are activated after click. The main camera („*Main Camera")*scans the whole scene and further inserted camera („*Camera"* - any number of cameras could be inserted) is de facto (actually) the user, it means he moves, he looks to the place, where the visitor of the medieval castle wishes. All interactive elements are described in C#, which defines all required movements of the mouse and keyboard.

Completed interactive presentation exported in user´s environment. Due to a fact that presentation should be started in all internet viewers (it is necessary to install Unity Web Player), the platform „*Web Player*" was selected. Outcoming set for starting is in format HTML.

3.1. Aims and methodology of research

Goal of the inquiry project was to find out, if implementation of gamification elements with historical topic can have an influence on pedagogical communication and interaction in the frame of subject matter on the 1st level of basic school. We posed following questions:

- What were partial interaction characteristics of all lessons from the standpoint of the occurrence of followed activity categories?
- What were partial and total indexes of interaction in analyzed lessons?
- How the teachers evaluated the lesson?

On the base of determined goal and inquiry questions we selected as a fundamental research method standardized observation by means of well known category system. Actually it was modification of widened Flanders system of interaction analysis. We picked up this method from many reasons and one of them was even our conviction, that this method is on the boundary of quantitative and qualitative processes of research. It summarizes interaction among the participants of education under the conditions of lessons, at the same time introduces the time standpoint and brings in sequence needed dynamics. It is drawing near rather to a concept of case studies and concrete research cases.

Flanders´ approach comes from comprehension that lesson is formed with sequence of communication (interaction) acts, which repeat, both from the side of the teacher and the pupils, and their mutual share in the course of the lessons tells about characteristics. The word „acts" could be replaced with the concept of category of behavior and after it these categories of behavior transfer on concrete activity, to be possible to follow and determine them (Svatoš, Doležalová, 2011).

In Flanders original system the categories for recording the activities of pupil were essentially less structured than the categories describing activity of the teacher (it corresponds with original task). Due to this reality we tended to modified version of FIAS (Flanders Analysis Interaction System) methods, which was made broader by T. Svatoš and J. Doležalová (2009) in the area of pupil behavior in such way to balance the followed parameters. We followed sixteen categories in total, which we defined as follows (Maněnová, 2013).

U1 – Teacher accepts pupil's feelings and behavior, tries to show sympathy in a constructive way

U2 – Teacher values pupil positively, expresses favourable opinion of work, answers, actions, characteristics or behavior, is encouraging, makes jokes, generally values achievement

U3 – Teacher uses, elucidates, develops, or accepts what pupil suggests, repeats pupil's statements in order to stress their value so others can remember them, paraphrases or modifies answers or comments on the task

U4 – Teacher summarises and makes responses more precise, compares pupil statements

U5 – Teacher asks questions about the task, method of working or organisation, expects answers rather than asking rhetorical questions, uses questions to stimulate pupil

U6 – Teacher explains, informs, introduces own opinion, acquaints pupil with own attitudes and values, elucidates or glosses subject matter (we include the use of video and sound recordings here, as it is the teacher who selects them)

U7 – Teacher gives instructions or orders, criticises outcomes, answers, actions or behavior, gives reasons for own methods, explains why particular approaches or actions are necessary, establishes rules, enforces authority, tries to

change pupil's unsuitable behavior or actions
Z1 – Pupil asks questions, seeks help and support from teacher
Z2 – Pupil asks questions, seeks help and support from other pupils
Z3 – Pupil states, explains and introduces own opinions when pressured or influenced by teacher, answers when called on to do so rather than raising hand first
Z4 – Pupil states, explains and introduces own opinions arising from own actions or motivation, raising hand when answering questions or spontaneously referring to own experience or opinion
Z5 – Pupil directs or modifies actions of others, offers them help (we include here any presentation by the pupil, such as use of the blackboard when 'teaching' other pupils)
Z6 – It communicates with other pupils during a team activity
Z7 – It participates in whole class discussion
Z8 – Pupils pursues individual learning activity without visible interaction
O1 – It is silent or confused, stops working, communicates indistinctly
Data, which were obtained from structured observation, we evaluated from two viewpoints. The first one compilation of classical quantitative surveys (in the graphs and tables). These surveys expressed absolute and relative frequency of the shares of separate activity categories to the whole. This way time cuts were evaluated, i.e. time sections of lesson which were interesting for us from certain viewpoint.

The second viewpoint on obtained data was aimed on grouping of separate activities of the teacher and pupils in activity „bunches“, which formed after statistical processing separate indexes, with which the level of communication and interaction in the followed lessons could be described. There the following set and partial indexes (Svatoš, Doležalová, 2011, p. 11):

Ii = Az/Au
Where:
Ii - combined index of interaction;
Az - index of pupil activity (Zo+Za+Zp);
Au - index of teacher activity (Ua+Uv+Ur);
K - total number of coding categories O1;
Zo - index of pupil's seeking of help and support (Z1+Z2)/K;
Za - index of pupil's activity (Z3+Z4+Z8)/K;
Zp - index of pupil moving towards teaching others (Z5+Z6+Z7)/K;
Ua - index of teacher's acceptance of pupil (U1+U2+U3)/K;
Uv - index of teacher's active teaching (U4+U5)/K;
Ur - index of teacher's dominant role in teaching (U6+U7)/K.

It could be generally stated, if the index of interaction is equal 1, then the lesson from the side of a teacher and even pupils was balanced. If the index of interaction is higher than 1, it testifies about greater pupils activity, if the index of interaction is smaller than 1, it is case of a dominant share of the teacher in mutual communication and interaction.

For obtaining data and basic quantitative processing (tables of frequency of separate categories graphic cross section of lesson unit from the viewpoint of separate categories and a time record of separate categories) special program CodeNet was used, which was developed at the department of pedagogy and psychology of Pedagogical Faculty, University Hradec Králové (authors: T. Svatoš and V. Žák). This program enables to define 20 any followed activity categories, further code interval could be adjusted. Last but not least it makes possible to form time sections – partial data sets corresponding to selected starting and ending codes from the total set. It archives and exports the result to Excel (Svatoš, Doležalová, 2011).

In spite to a fact that it is case of quantitative processing of the obtained data, the above described FIAS method characterizes always the concrete lesson. So it is not possible to generalize obtained knowledge, to deduce more lasting aspects. We recorded the lesson on video and after we carried out coding from the videos.

3.2. Research sample

The research was carried out from November 2013 then the videos of lesson were processed. Regarding to that it was 3D model of castle, which used to stand in Hradec Králové, we were limited by the place, it is by Hradec Králové. We selected 11 schools, from which in three the teachers were willing to frame the lesson of Man and his world with created model implementation.

It was rather demanding methodical work for the teachers, which they consulted with us. The model of castle was freely incorporated in lesson with an attempt to arose pupils activity. We done three videos of lessons. Next we realized discussions with teachers and found their opinion on possibility of application of 3D models in lessons.

3.3. Research results

The obtained videos of lessons gave us the view on the lesson from the standpoint of pedagogical communication and interaction. In the first phase we concentrated on separate partial interaction characteristics of all followed lessons from the viewpoint of occurrence of determined activity categories (Fig.2).

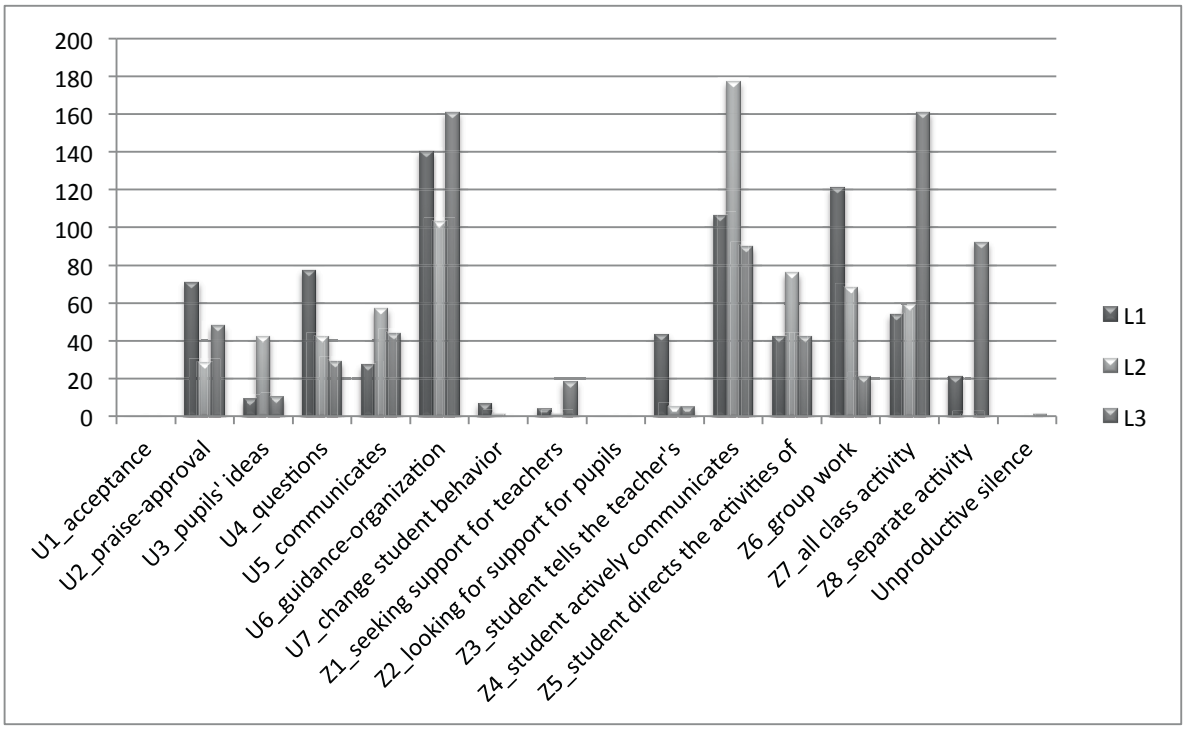

Fig. 2 Activity categories observed in lessons

We calculated in all followed lessons partial and total indexes of interaction (Tab.1).

Tab. 1 Interaction indicators in lessons

	L1	L2	L3
$\mathbf{U_a}$	0,11	0,11	0,08
$\mathbf{U_v}$	0,14	0,15	0,10
$\mathbf{U_r}$	0,20	0,16	0,22
$\mathbf{Z_o}$	0,01	0,00	0,02
$\mathbf{Z_a}$	0,24	0,28	0,26
$\mathbf{Z_p}$	0,30	0,31	0,31
$\mathbf{A_u}$	0,46	0,41	0,40
$\mathbf{A_z}$	0,54	0,59	0,60
$\mathbf{I_i}$	1,18	1,41	1,47

It follows from the separate lessons, that total interaction index was in all three cases higher than 1.0.It means that activity of pupils overbalanced. Due to the fact that we personally recorded all lessons, the result corresponds with our observation of lessons.

We had discussions with all three teachers. Implementation of 3D model of the castle represented a certain challenge for them. They posed a question, if they would be able to use methodologically well the model. White board was used in lessons for the presentation of the model and work with it. In the first lesson the model was included to the fixed part of lesson. It was surprising for pupils, but they quickly learned to work with the model and found out typical elements, e.g. broken arc. In remaining lessons 3D model was exploited as a motivation element for subject matter about city Hradec Králové. We again met with moment of surprise from the side of pupils and than with very quick acceptance of the new element in learning.

It follows from the discussion with teachers that they embrace such animation of lesson. They must aimed on correct or suitable didactic application of the model. Here they find out their certain insufficient education and they would welcome basic course even for creating of these models.

4. Conclusion

Information and communication technologies offer wide utilization in educational process. Nowadays the schools respectively classrooms are equipped with white boards, which makes possible a certain number of tasks. Use of 3D models in connection with gamification makes exploitation of white board broader and tries to active pupils more, with help of activities closer to them.

We are aware that our project was a pilote one and it is not possible to generalize the obtained findings. Our aim was to create more models and use them in greater extent and number in lessons.

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